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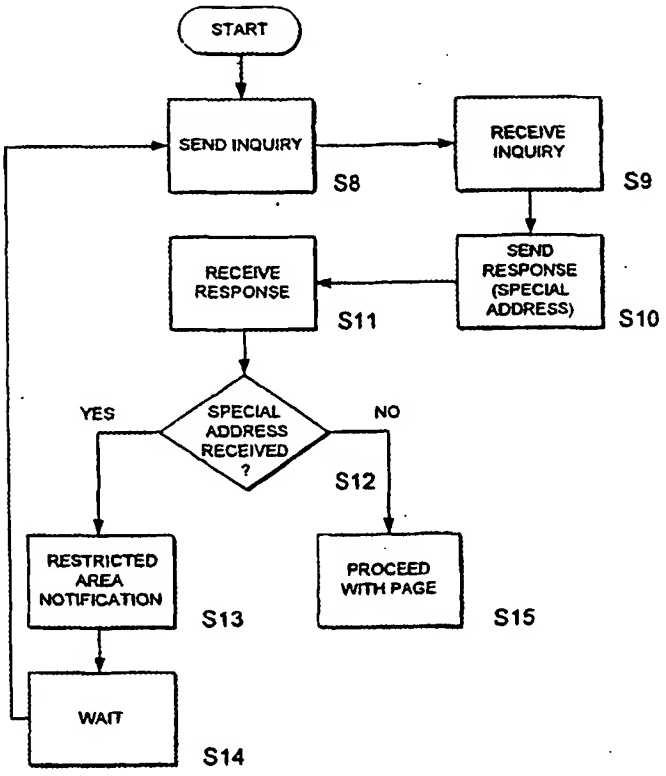
(54) Title: METHOD AND APPARATUS FOR TRANSMISSION RESTRICTION OF PORTABLE RADIO DEVICES



(57) Abstract: Many types of electronic equipment emit radio frequency signals. There are environments where the transmission of radio signals may be hazardous, unwelcome or should be restricted in a particular way. These environments include schools, hospitals, theatres, cinemas, conference centres and offices. The presence of such electronic equipment (1, 5) is detected and a controlling device (4, 5, 6, 16, 21) instructs the equipment to suppress radio transmission.

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METHOD AND APPARATUS FOR TRANSMISSION RESTRICTION OF PORTABLE RADIO DEVICES

Technical Field

The present invention relates to control apparatus to control radio frequency transmission from electronic equipment.

Background Art

Many types of electronic equipment emit radio frequency signals. This is not limited to types of equipment that are primarily used for communications, such as cellular telephones. Computers, keyboards, printers and facsimile machines may be interconnected by means of wireless networks based on radio links. Increasingly, many types of equipment, such as cellular telephones, personal organisers and lap-top computers are portable and may be configured to automatically connect to and register their presence on a local network.

There are environments where the transmission of radio signals may be hazardous, unwelcome or should be restricted in a particular way. These environments include schools, hospitals, theatres, cinemas, conference centres and offices.

GB-A-2329794 discloses a system for disabling electronic equipment. As a piece of electronic equipment passes through a loop antenna, it picks up an instruction, which is repeatedly transmitted by the antenna, to disable itself. The electronic equipment complies with the request and returns an acknowledgement to indicate compliance.

The present invention seeks to improve upon this system by detecting signals emitted by the electronic equipment and in dependence upon the signals, instructing the equipment to limit its use.

Disclosure of Invention

According to the present invention there is provided apparatus to control operation of a device within a restricted area comprising means for detecting the presence of the device and means for instructing the device to restrict its operation.

The means for detecting the presence of the device may comprise first receiver means for receiving a signalling message emitted by the device.

The signalling message may be emitted by electromagnetic radiation and the frequency of the electromagnetic radiation may be in the range 1MHz to 1THz.

The instructing means may comprise a transmitter means for transmitting a control signal in dependence on the first receiver means receiving the signalling message.

The signalling message may comprise an invitation to another device to transmit a response.

The control message may be emitted by electromagnetic radiation and the frequency of the electromagnetic radiation may be in the range 1MHz to 1THz.

The first receiver means may be located in the restricted area.

The first receiver means may be located at an entry point to the restricted area.

The apparatus may further comprise means for restricting operation of the device comprising second receiver means at the device to receive the control signal.

The device may be a mobile terminal for operation in a telecommunications network.

The telecommunications network may comprise one of a plurality of 2nd generation mobile standards and said one of the plurality of 2nd generation mobile standards may be the global system mobile (GSM).

The telecommunications network may comprise one of a plurality of 3rd generation mobile standards and said one of the plurality of 3rd generation mobile standards may be the universal mobile telephone system (UMTS).

The telecommunications network may comprise a land-based cellular mobile communications network.

The device may comprise a computer.

The computer may be a lap-top computer or may be a palm held computer.

The device may further comprise a communication device.

The device may comprise means to establish a network connection.

The means to establish a network connection may comprise a chip for operating in the Bluetooth system.

The means for detecting the presence of the device may comprise tag-detecting means for detecting the presence of a tag carried by the device.

The tag may comprise magnetic material.

The tag may be configured to store readable data.

The instructing means may comprise a transmitter means for transmitting a control signal in dependence on detecting the presence of the tag.

The control message may be emitted by electromagnetic radiation.

The frequency of the electromagnetic radiation may be in the range 1MHz to 1THz.

The first receiver means may be located in the restricted area.

The first receiver means may be located at an entry point to the restricted area.

The apparatus may further comprise means for restricting operation of the device comprising second receiver means at the device to receive the control signal.

The device may comprise means for restricting its operation.

The means for restricting operation may comprise means for restricting radio frequency transmission.

The means for restricting operation may be configurable to restrict device operation for a fixed period of time.

The means for restricting operation may be configurable to restrict device operation until instructed otherwise.

According to the present invention there is further provided a method of controlling operation of a device within a restricted area comprising detecting the presence of the device and instructing the device to restrict it operation.

Brief Description of Drawings

Embodiments of the present invention will now be described, by way of example, with reference to the following drawings, in which:-

Figure 1 shows two portable computers connected by means of a wireless link;

Figure 2 is a sequence diagram showing the transfer of messages between two transceiver units when establishing a wireless connection;

Figure 3 is a process flow diagram by which an attempt to establish a connection between the two computers is suppressed;

Figure 4 is an interior view of a room in a hospital;

Figure 5 is a schematic diagram of a mobile telephone network;

Figure 6 is a plan view of the floor layout within a hospital and

Figure 7 is a schematic diagram of a magnetic tag detector.

Best Modes for Carrying Out the Invention

First Embodiment

In a first embodiment of the present invention, a wireless network may be established between a collection of electronic devices through the Bluetooth™ system. A system specification (Version 1.0) and a system overview may be found on the world-wide web at http://www.bluetooth.com.

The Bluetooth system replaces cable connections between electronic devices with short-range radio links. The system is configured to connect between two and eight devices to form a "piconet". One device within the piconet serves as a master unit and its clock is used to synchronise communication throughout the piconet. Both voice and data may be communicated through the piconet. Overlapping piconets may be linked together to form a "scatternet".

To realise wireless connection between electronic devices, each device carries a multifunctional chip unit. In this example, the chip unit comprises a radio transceiver to provide the wireless link, a link controller to control the physical establishment of the radio link and a link manager to manage the execution of link protocols and to interface with the electronic device. Alternatively, the chip unit comprises the radio receiver and the host device executes the higher level functions or shares execution of these functions with the chip unit.

The radio transceiver operates at 2.4 GHz, uses spread-spectrum techniques and has a typical broadcast range of 0.1 to 10 meters. However, it will be appreciated that other operating frequencies at megahertz, gigahertz and terahertz frequencies may be used.

Referring to Figures 1 and 2, a brief overview of how a connection is established between two portable computers 1, 2 will now be described.

A first portable computer 1 carries a first Bluetooth unit 3. Under normal conditions, the unit 3 operates in a low-power consumption standby mode. The unit 3 periodically "wakes-up" and enters an inquiry mode and repeatedly broadcasts inquiry message over a set of frequencies, inviting other devices to respond (Step S1). The inquiry message may specify that only certain types of devices should respond and this is specified as an access code at the beginning of the message. Having broadcast an inquiry message, the unit 3 listens for inquiry response messages on a different set of frequencies. A second unit 4 carried by the second portable computer 2 receives the inquiry message and replies with an inquiry response message, which contains its device address (Step S2).

The first unit 3, now in possession of the second unit's device address, passes into page mode. A page message is transmitted using a hopping sequence determined by the device address (Step S3). The second unit 4 receives the page message and replies by sending a page response message (Step S4). The process by which the second unit 4 begins to synchronise to the first unit's clock now begins. The first unit 3 sends a special control packet that includes information relating to its clock data and the channel hopping sequence to be used and a second unit confirms receipt with a response (Steps S5 and S6). The first and second units 3, 4 are now in a connected state and can begin exchanging packets of data (Step S7) and through them the first and second portable computers 1, 2 are connected by means of a piconet. Higher level protocols manage the exchange of information between the two computers 1, 2.

The second unit 4 in the connected state can operate in several modes. In an active mode, the second unit 4 listens to time and frequency slots for data packets from the first unit 3 and then sends data packets in other allocated slots. However, if no data is being transferred then the first unit 3 can arrange for the second unit 4 to be put in a power-saving mode. In such a mode, a hold mode, an internal timer is started and the second unit 4 becomes inactive for a fixed duration. Alternatively, the second unit 4 may be placed into sniff mode during which it polls the piconet at a reduced rate. Finally, the second unit 4 may be placed in park mode, wherein it surrenders its device address and does not participate in data traffic.

Referring to Figure 3, the process by which the second portable computer 2 can suppress radio transmission from the first portable computer 1 will now be described.

A hospital room is temporarily designated as an area where radio transmissions should be restricted. The hospital staff operate the second portable computer 2, carrying the second Bluetooth unit 4. A dedicated user application is loaded and run on the portable computer 2 in order to configure the second unit 4 and place it in a suppress mode, i.e. suppress radio transmission of all devices within range. Once configured, the second unit 4 listens out for page and inquiry messages on

several hop frequencies. If the second unit 4 receives, for example, an inquiry message sent by the first device 3 (Steps S8 & S9), it replies with a modified inquiry response message (Step S10). The second unit 4 issues a specially designated device address, to signify that the inquiry process should be suspended and that no further inquiry messages should be broadcast for a fixed time period. The specially designated device address is effectively a command to suspend transmission. The first unit 3 receives the response and checks the device address (Step S11 & S12). If the first unit 3 receives the specially designated device address, it notifies the user that the first computer 1 is within an area of restricted radio use (Step S13) and suspends the inquiry process for a fixed period of time (Step S14). If the first unit 3 receives a normal device address, the paging process continues as described earlier (Step S15). In another example, rather than suspending transmission of inquiry messages for a fixed time, suspension may be indefinite and may be overridden by entering a PIN number.

A long-term solution to suppressing radio transmission would be to have one or more Bluetooth units permanently located within the room.

Referring to Figure 4, a first dedicated 5 unit having a low-power transceiver may be embedded in a door-frame. Alternatively or additionally, a second dedicated unit 6 unit with a higher transmission power may be located in the ceiling in the centre of the room. In both cases, the units are configured to respond to any inquiry or page message with the specially designated device address so as to suppress further radio transmission.

The example described above involves suppressing the connection process at the earliest instance. However, an instruction to suppress radio transmission may be issued at any time during the establishment of a connection. In one example, the radio link is fully established as shown by Step S7 in Figure 2. Once the exchange of traffic has been enabled, the second unit 4 commands the first unit 3 to switch to standby mode.

It will be appreciated that the first and second units 3, 4 may be carried by any type of electronic devices. For example, instead of a first portable computer 1, a mobile telephone may carry the first unit 3 in order to issue inquiry messages. Similarly, instead of the second portable computer 2, a desk-top computer may carry the second unit 4 to suppress transmission of inquiry messages.

It will also be appreciated that the second unit 4 may be placed in other locations, such as in the corner of the room, under the floor or with walls. Furthermore, the second unit 4 may be provided with an antenna, for instance a portable loop antenna positioned within the doorframe.

It will also be appreciated that the second unit 4 may be used to suppress the broadcast inquiry messages of more than one unit within the restricted area.

Second Embodiment

In a second embodiment of the present invention, communication with a mobile telephone handset may be provided through public land mobile networks. These networks may operate according to analog or digital standards. For example, the Global System Mobile (GSM) network is a 2nd generation, digital standard that operates in Europe and elsewhere. Code Divisional Multiple Access (CDMA) and Digital American Mobile Phone System (DAMPS) are 2nd generation, digital standards that operate in the US. Personal Digital Cellular (PDC) and Personal Handyphone Service (PHS) systems are 2nd generation, digital standards that operate in Japan.

In the GSM network, individual cells are served by a plurality of geographically spaced base station subsystems (BSS), each comprising a base transceiver station (BTS) which is coupled through base station controllers (BSC) to mobile switching centres (MSC). The MSCs may provide a gateway out of the network to a conventional public switched telephone network (PSTN). The network includes a home location register (HLR) which stores information about subscribers to the system and their mobile stations (MSs). When an MS is switched on, it registers with the HLR. If the user roams to a different GSM network, the mobile station

registers with a visitor location register (VLR) of the visited network, which communicates with the HLR of the home network for routing and other purposes.

An overview of the GSM system is given in "The GSM System for Mobile Communications" by M. Mouly and M.-B. Pautet (Cell & Sys., Palaiseau, 1992).

Referring to Figure 5, a brief overview of how a connection is established between a first MS 7 located within the PLMN 8 and a fixed terminal 9 located in the PSTN 10.

A user initiates a call on the MS 7 by dialling the network number of the fixed terminal 9 and pressing a SEND key. This initiates the access procedure at a radio resource level, which is now described. The MS 7 broadcasts an 8-bit channel request message on a random access channel (RACH). This message comprises an identifier, which the mobile station randomly generates so that it can identify a response. This message is received by a BTS 11, which in turn indicates to a BSC 12 that a channel is required. The BSC 12 is allocated a channel by the MSC 13. The BSC 12 instructs the BTS 11 to use a traffic channel (TACH) that is currently free. The BTS 11 sends an immediate assignment message on a paging and access grant channel (PAGCH) containing the identity of the allocated traffic channel.

It is assumed that the MS 7 is located within its home PLMN 8 and that its current location is registered at the HLR 14. It is assumed that mobility and security management procedures are performed in manners well known *per se*.

Once a connection has been established between the MS 7 and the MSC 13, the process of actually connecting the call can proceed. This level of functionality is known as the Call Control level. The MS 7 sends to the MSC 13 a SETUP request message, which contains the destination network number of the fixed terminal 9. The MSC 13 sends an initial address message to the PSTN 10, while returning a call proceeding message to the MS 7. Once the MSC 13 receives confirmation that the fixed terminal 9 has been successfully contacted the MSC 13 passes on an alerting message to the MS 7. Once the fixed terminal 9 lifts the handset, the MSC 13 sends a connect acknowledgement and the call proceeds.

The MS 7 transmits signals when it updates its location. The MS 7 carries out the access procedure as described earlier and transmits a location updating request, which includes information necessary to identify the user.

Referring to Figure 6, the process by which a first control unit 16 may suppress radio transmission from the first MS 7 will now be described.

A user, carrying the first MS 7, may pass close to an operation theatre 17, which contains many sensitive instruments. Corridors 18a, 18b, 18c and doors 19a, 19b leading to the operation theatre 17 are served by the first control unit 16. The first control unit 16 provides dedicated BTS/BSC functionality. Leaky feeders 20a, 20b are connected to the first control unit 16 and are run along the ceilings of the corridors 18a, 18b as antennae.

If the user initiates a call or location updating, the MS 7 will broadcast a channel request message on the RACH. The first control unit 16 receives this message, via antennae 20a, 20b, and sends an immediate assignment reject message on the PAGCH. The effect of this message is to prevent the mobile MS 7 from attempting access for a fixed amount of time.

Instead of transmitting an immediate assignment reject message on the PAGCH, the control unit 16 may transmit an instruction over the broadcast control channel (BCCH). This allows the first control unit 16 the added flexibility of pre-empting the MS 7 and instructing the MS 7 not to broadcast at all.

It will be appreciated that radio transmission by a mobile terminal operating according to different standards, with different network architecture and different air interfaces may also be suppressed. One such standard is the Universal Mobile Telephone system (UMTS) that communicates through broadband, packet-switched networks. In such a system, a mobile terminal will increasingly be used for data services and e-commerce.

An overview of UMTS is given in "UMTS: the next generation of mobile radio" by M. Gallagher and W. Webb, pp. 59-63, IEE Review, March 1999.

Other standards, similar to UMTS in that they are also 3rd generation standards, include "3g" in the US and CDMA1 in Japan.

It will also be appreciated that radio transmission by a mobile terminal operating according to non-cellular based Enhanced Specialised Mobile Radio Service (ESMR) and satellite-based Global Mobile Personal Communication Services (GMPCS) may also be suppressed.

Third Embodiment

In a third embodiment of the present invention, an electronic device capable of transmitting radio signals carries a readable magnetic tag similar to those used for theft prevention. If the electronic device passes through an interrogation zone and if it is identified as a type of device that should be disabled, a control signal is broadcast to instruct the device to disable itself.

The magnetic tag comprises an array of magnetic elements and each element may be magnetised or unmagnetised. The magnetic elements have high values of relative permeability ($>10^3$) and low coercivity ($<10Am^{-1}$). A magnetic field is generated within the interrogation zone, which comprises at least two magnetic field components. The first is a static magnetic field of high field strength generated by an arrangement of opposing electromagnets. The electromagnets are arranged in such a way that a region of zero magnetic field is generated, which is known as a magnetic null. The second is superimposed upon the first and is a high frequency alternating magnetic field of smaller field amplitude. This is the interrogation field and causes the position of the magnetic null to oscillate a little. Optionally, a third component, a low frequency alternating field, may also be superimposed in order to scan the magnetic null. This is known in the art as a flying null.

As the magnetic tag passes through the interrogator, the static magnetic field saturates the magnetic elements. However, when the magnetic elements pass through the magnetic null, they are no longer saturated and this allows the high frequency alternating field to interact with the magnetic elements, resulting in the elements generating harmonics of the high-frequency field. As each element of the

tag passes through the magnetic null, it will generate a signal. Thus, if the elements are spaced at different intervals, a characteristic signal will be generated. It is helpful to think of this as a magnetic equivalent of an optical bar code.

Examples of readable magnetic tags may be found in WO 96/31790 and WO 97/04338.

Referring to Figure 7, the apparatus by which a second control unit 21 detects the presence of second MS 22 and suppresses radio transmission will now be described.

A magnetic tag 23 is embedded within the plastic casing of the second MS 22. The tag 23 carries a magnetic signature corresponding to the system in use, for instance the GSM network.

A set of transmitter coils 24 and receiver coils 25 are located within a corridor and these define the interrogation zone. As the user passes through the interrogating zone, the receiver coils 24 detects the harmonic responses of the magnetic tag 23. The signal generated by the receiver coils 24 is filtered, amplified, correlated and analysed by the control unit 21 to determine the magnetic signature of the tag 23. The second control unit 21 identifies the tag 23 as being one that is carried by a GSM terminal and accordingly sends signals to instruct the second MS 22 to disable itself. The disabling signals are sent by a dedicated radio transmitter 26 via an antenna 27 over the BCCH. Alternatively, the disabling signals may be sent over the PAGCH.

Could be a multiple by wired Tx 26 can adapt to MS, but has to be triggered in response to detection of the magnetic identification tag.

Alternatively, an audible warning may be given, instructing the users to switch-off their mobile telephones.

It will be appreciated that a Bluetooth unit as described in a previous embodiment may have a magnetic tag built into it. This enables the control unit to detect the presence of the unit before it transmits any radio signal and instruct it to disable itself.

It will be appreciated that many modifications may be made to the embodiments above. For example, an electronic device may emit infra-red signals and these are detected by a detector which notifies a control unit. The control unit infers the presence of an electronic device that is capable of transmitting radio frequency signals and instructs the device to disable itself.

In another example, the electronic device may emit an audible alert to notify the user or the authorities that the device is within a restricted area.

In another example, when a control unit, for instance portable computer carrying a Bluetooth unit, detects a signal, it notifies the relevant authorities, for example a security guard.

Claims

1. Apparatus to control operation of a device within a restricted area comprising means for detecting the presence of the device and means for instructing the device to restrict its operation.

2. Apparatus according to claim 1 wherein the means for detecting the presence of the device comprises first receiver means for receiving a signalling message emitted by the device.

3. Apparatus according to claim 2 wherein the signalling message is emitted by electromagnetic radiation.

4. Apparatus according to claim 3 wherein the frequency of the electromagnetic radiation is in the range 1MHz to 1THz.

5. Apparatus according to any one of claims 2 to 4 wherein the instructing means comprises a transmitter means for transmitting a control signal in dependence on the first receiver means receiving the signalling message.

6. Apparatus according to any one of claims 2 to 5 wherein the signalling message comprises an invitation to another device to transmit a response.

7. Apparatus according to claim 5 or 6 wherein the control message is emitted by electromagnetic radiation.

8. Apparatus according to claim 7 wherein the frequency of the electromagnetic radiation is in the range 1MHz to 1THz.

9. Apparatus according to any one of claims 2 to 8 wherein the first receiver means is located in the restricted area.

10. Apparatus according to any one of claims 2 to 8 wherein the first receiver means is located at an entry point to the restricted area.

11. Apparatus according to claim 5 further comprising means for restricting operation of the device comprising second receiver means at the device to receive the control signal.

12. Apparatus according to any preceding claim wherein the device is a mobile terminal for operation in a telecommunications network.

13. Apparatus according to claim 12 wherein the telecommunications network comprises one of a plurality of 2nd generation mobile standards.

14. Apparatus according to claim 13 wherein said one of the plurality of 2nd generation mobile standards is the global system mobile (GSM) network.

15. Apparatus according to claim 12 wherein the telecommunications network comprises one of a plurality of 3rd generation mobile standards.

16. Apparatus according to claim 15 wherein said one of the plurality of 3rd generation mobile standards is the universal mobile telephone system (UMTS).

17. Apparatus according to claim 12 wherein the telecommunications network comprises a land-based cellular mobile communications network.

18. Apparatus according to any one of claims 1 to 11 wherein the device comprises a computer.

19. Apparatus according to claim 18 wherein the computer is a lap-top computer.

20. Apparatus according to claim 18 wherein the computer is a palm held computer.

21. Apparatus according to any one of claims 18 to 20 wherein the device further comprises a communication device.

22. Apparatus according to any preceding claim wherein the device comprises means to establish a network connection.

23. Apparatus according to claim 22 wherein the means to establish a network connection comprises a chip for operating in the Bluetooth system.

24. Apparatus according to claim 1 wherein the means for detecting the presence of the device comprises tag-detecting means for detecting the presence of a tag carried by the device.

25. Apparatus according to claim 24 wherein the tag comprises magnetic material.

26. Apparatus according to claim 24 or 25 wherein the tag is configured to store readable data.

27. Apparatus according to any one of claims 24 to 26 wherein the instructing means comprises a transmitter means for transmitting a control signal in dependence on detecting the presence of the tag.

28. Apparatus according to claim 27 wherein the control message is emitted by electromagnetic radiation.

29. Apparatus according to claim 28 wherein the frequency of the electromagnetic radiation is in the range 1MHz to 1THz.

30. Apparatus according to any one of claims 24 to 29 wherein the first receiver means is located in the restricted area.

31. Apparatus according to any one of claims 24 to 29 wherein the first receiver means is located at an entry point to the restricted area.

32. Apparatus according to any one of claims 24 to 31 further comprising means for restricting operation of the device comprising second receiver means at the device to receive the control signal.

33. Apparatus according to any preceding claim wherein the device comprises means for restricting its operation.

34. Apparatus according to claim 33 wherein the means for restricting operation comprises means for restricting radio frequency transmission.

35. Apparatus according to claim 33 or 34 wherein the means for restricting operation is configurable to restrict device operation for a fixed period of time.

36. Apparatus according to claim 33 or 34 wherein the means for restricting operation is configurable to restrict device operation until instructed otherwise.

37. A method of controlling operation of a device within a restricted area comprising detecting the presence of the device and instructing the device to restrict it operation.

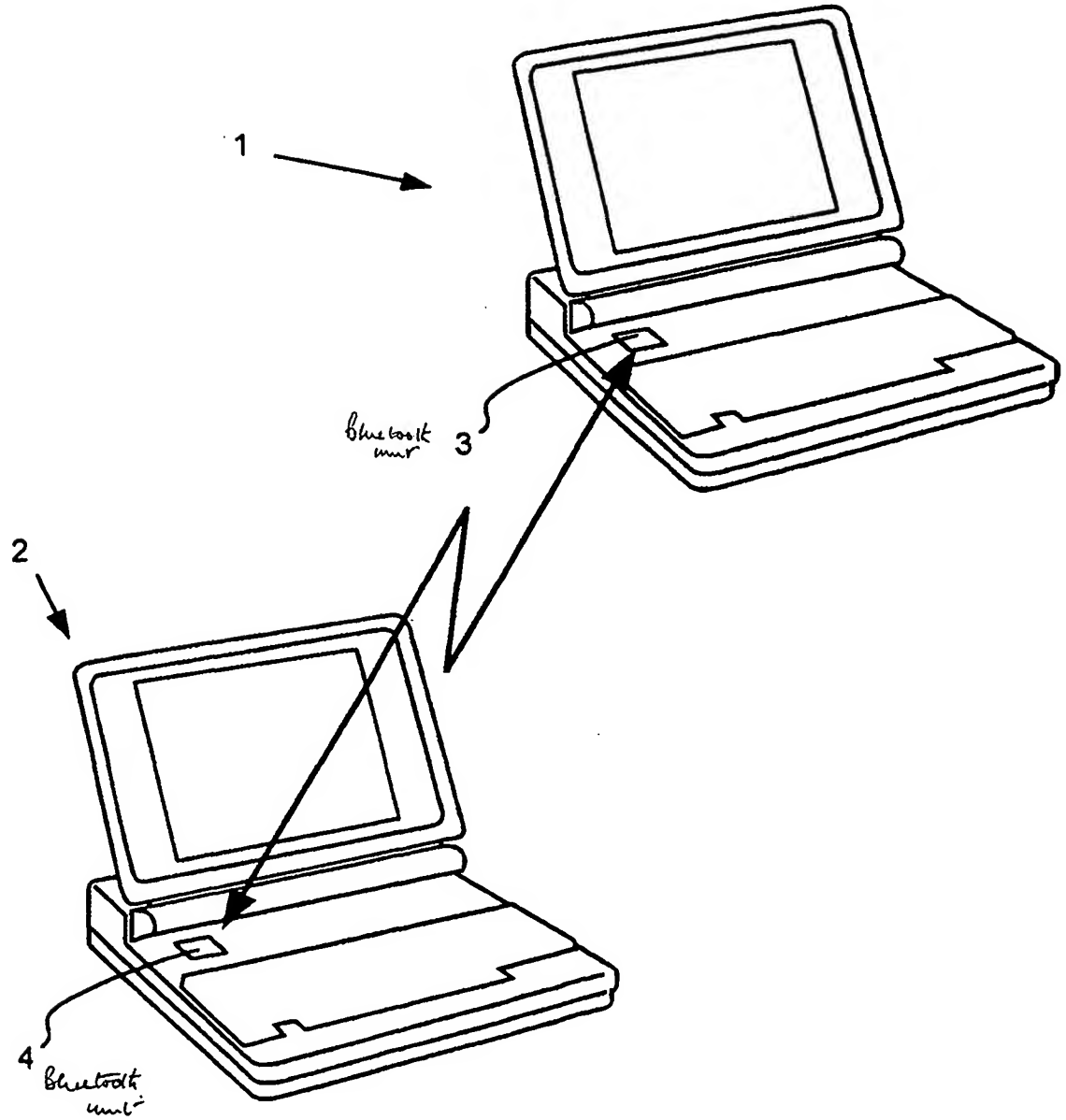

Figure 1

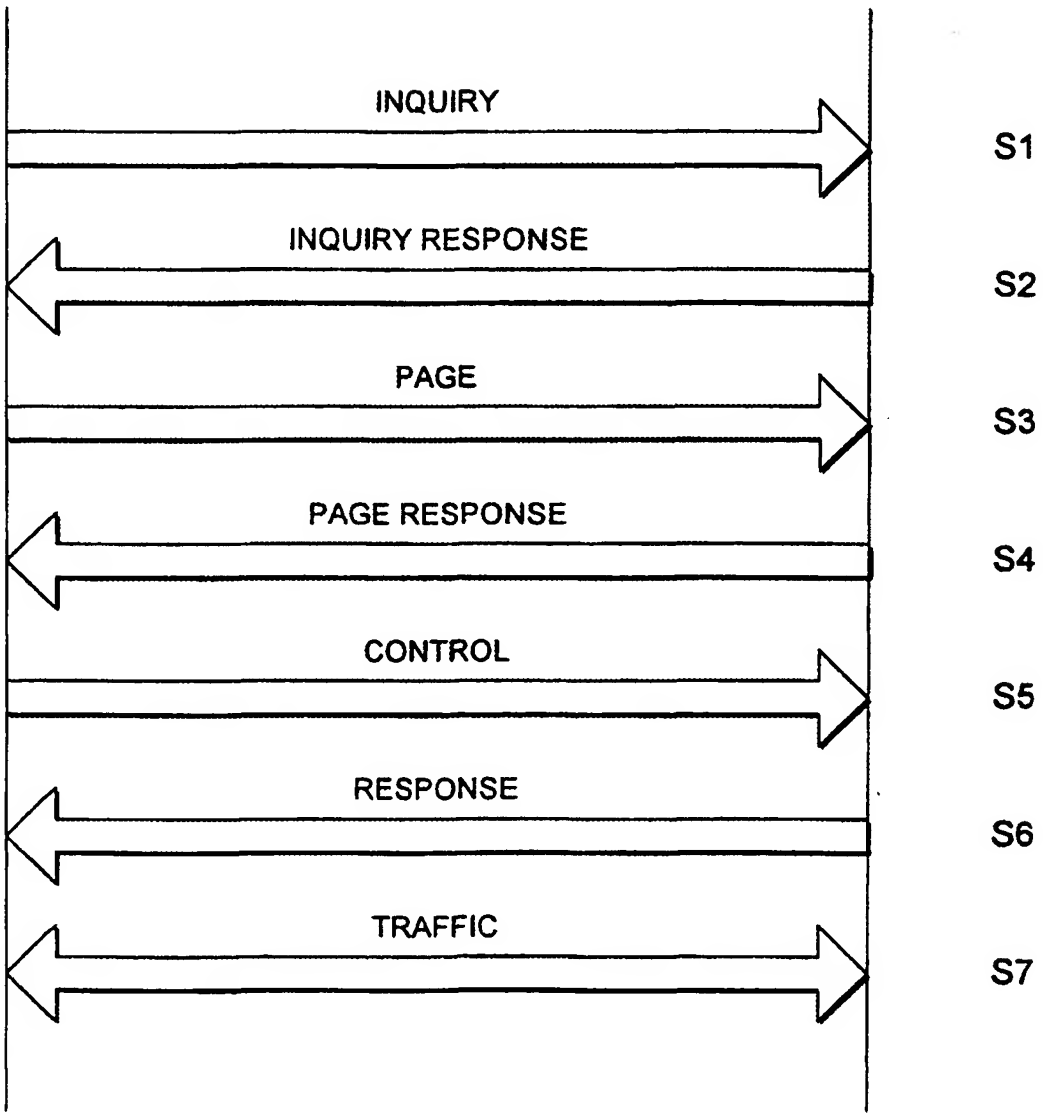

Figure 2

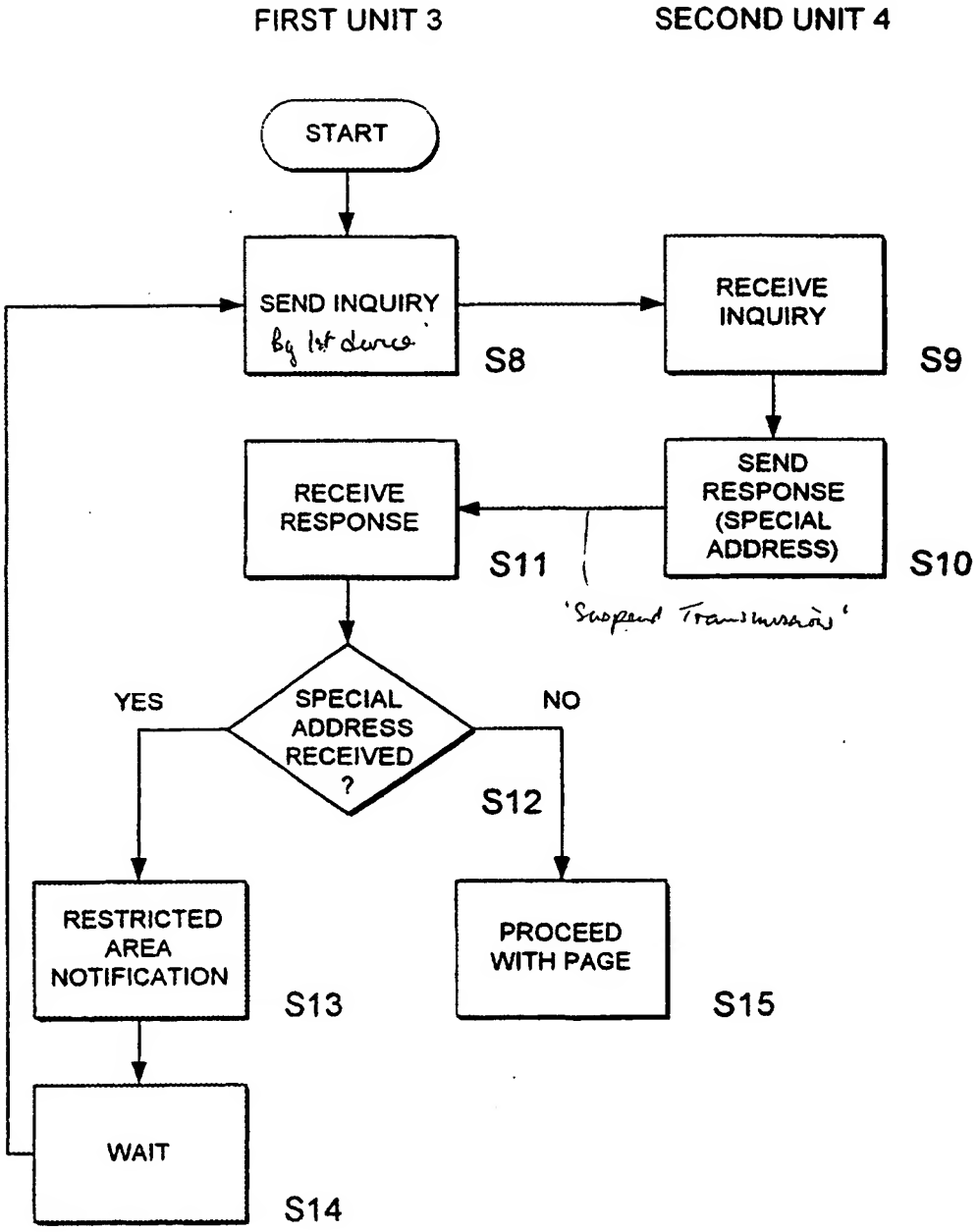

Figure 3

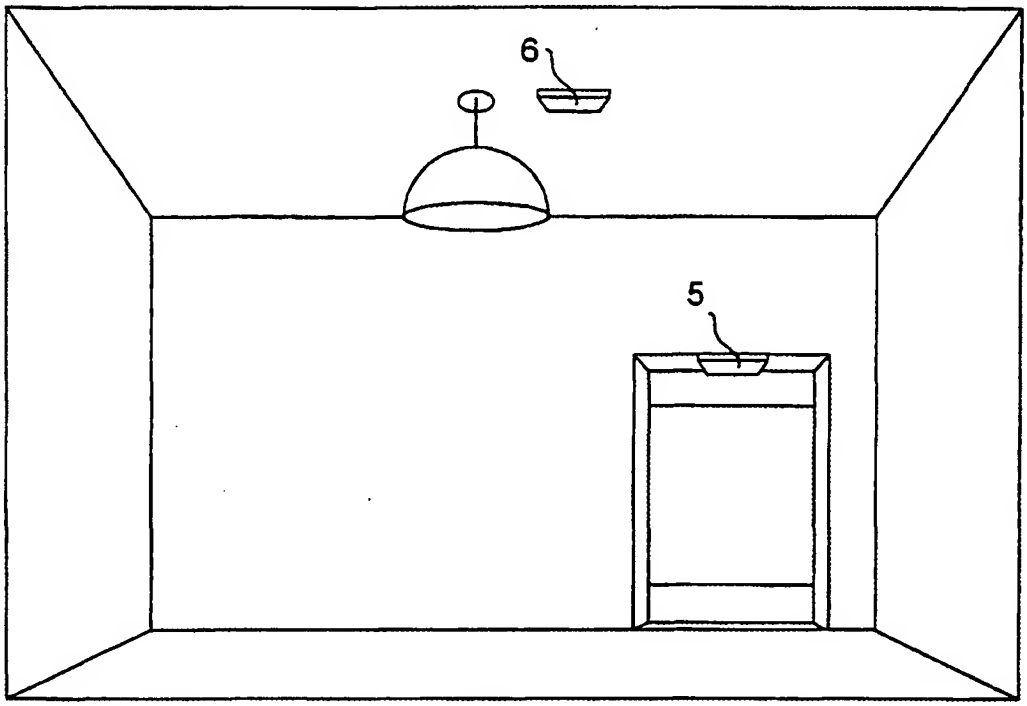

Figure 4

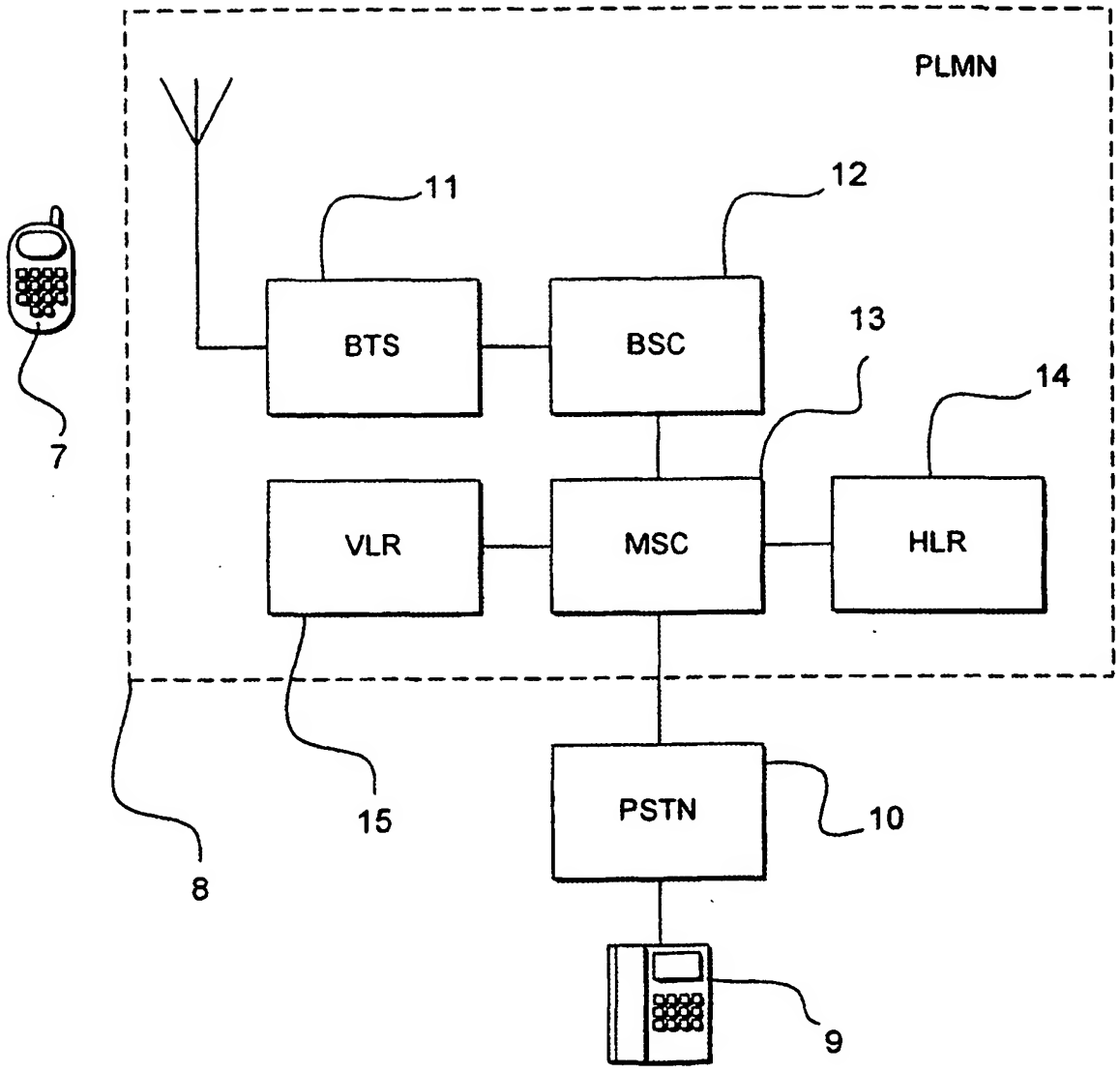

Figure 5

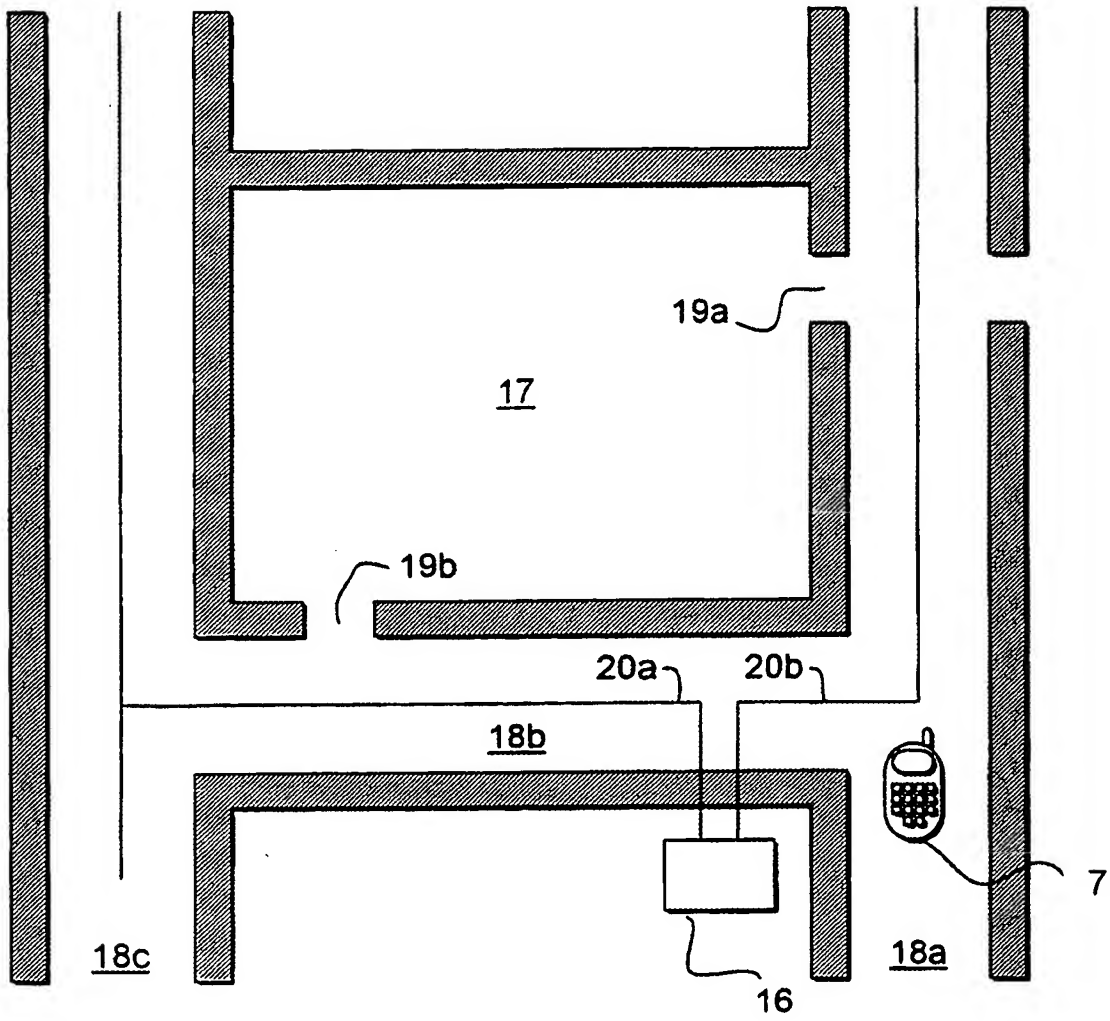

Figure 6

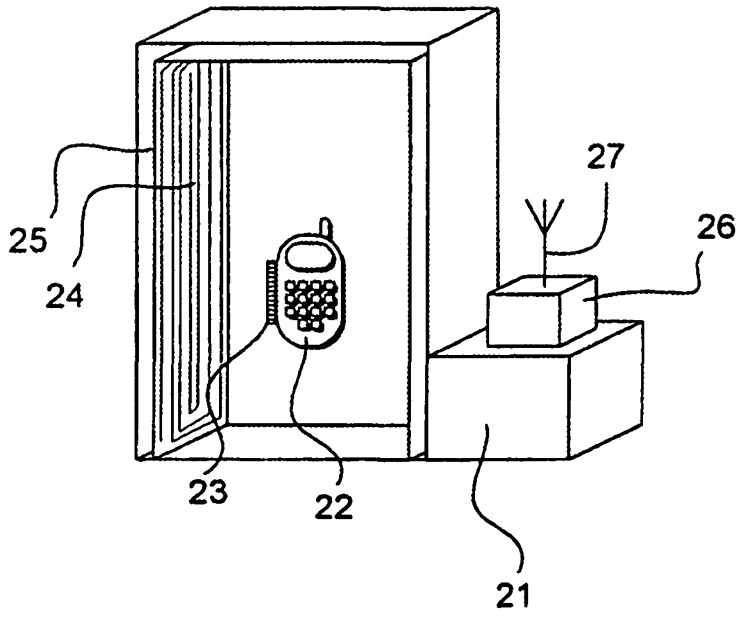

Figure 7